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TYPHOID FEVER AND MUNICIPAL ADMINISTRATION.[1]

By A. W. FREEMAN, Epidemiologist, United States Public Health Service.

Typhoid fever under the conditions of modern city life approaches absolute preventability. In this respect it stands almost alone among the communicable diseases commonly prevalent in the United States. Other diseases may be relatively preventable, or may be, within reasonable limits, controllable, but typhoid fever may be said to be, under practical working conditions, almost absolutely preventable. The means of spread of typhoid are so well understood and the measures of prevention so accurately determined that any city can, with the expenditure of a reasonable amount of money and effort, reduce its typhoid fever to the vanishing point.

Typhoid fever is unique also, in that its prevention may be accomplished with measures instituted and carried out by public authority, with a minimum of inconvenience to and effort on the part of the individual citizen. The control of most communicable diseases is concerned with the intimate details of the daily life of the citizens, and can be accomplished only by changes in these details usually brought about only after considerable effort over long periods of time. Typhoid control, however, is in very large part a function of the public sanitation of the community, and demands from the individual citizen only legal and financial support. Typhoid prevention, therefore, is in a peculiar sense a purchasable commodity, and as such is a measure of the real dollars-and-cents desire of the people for better health.

It is particularly fortunate, in connection with typhoid prevention, that the major measures necessary for its accomplishment are in line with what is ordinarily understood by the people at large to be reasonable and proper sanitary procedures. They are in line also with our inherited ideas of decency and cleanliness. In congratulating ourselves on the progress already made in typhoid prevention in cities we should not overlook the fact that much of this result is due to measures instituted from these primary considerations of cleanliness and decency, rather than from any real conscious effort to prevent typhoid fever.

The measures necessary for the prevention of typhoid fever in cities are, of course, well understood and need not be taken up in detail at this time. It would seem, however, advisable to consider the relative importance of various means of prevention and of the results which may properly be expected from their application.

The first essential in municipal typhoid prevention is, of course, the installation of a public water supply of the highest possible purity. Public opinion in the United States is probably more nearly unanimous on this point than on any other point in connection with public sanitation. Opinions may differ as to what constitutes a good supply, but practically everyone will agree on the necessity for pure water. It can not be too strongly emphasized that a public water supply, to be acceptable, must be absolutely pure at all times. A supply which falls short of the highest actual and potential purity will not prevent typhoid. It may reduce typhoid prevalence, since typhoid prevalence in cities is, within limits, proportional to the purity of the public water supply, but typhoid eradication may be accomplished only in the presence of a public supply of the highest possible purity. Engineering science has advanced to the point where such a supply can be obtained under almost all circumstances and at a cost not prohibitive.

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[1] Read before the Indiana Water Supply and Sanitary Association, Indianapolis, Ind., Feb. 15, 1917.

In connection with the question of water supply we must recognize the fact that a public water supply, to be effective in reducing typhoid prevalence, must be in use by all the citizens of a community. This is too often ignored in municipal administration. It is not uncommon to find a public water supply of high quality which is supplied to only half or even a third of the citizens of a populous community. The remainder of the citizens must depend upon private supplies, installed and operated without supervision of any kind, and open usually to great danger of pollution. Universal distribution of the public water supply is as essential as its installation.

The second essential in typhoid prevention is the immediate and complete removal from the community of all human excreta. This is accomplished, of course, only by a complete system of sanitary sewers to which every home in the community is connected. This is a truth which even the most advanced of modern sanitarians have been slow to recognize. The sewer systems of our cities have in large measure been installed from reasons of convenience and comfort, rather than from those of health. They are looked upon by a large proportion of the people as desirable from the standpoint of comfort, convenience, and decency, but not as an absolute essential to health. The result is that in our cities we find usually that the better and more thickly built up residential and business districts are connected with the sewers, while in the outlying and poorer sections of the city there are no sewers. The inhabitants of these sections must rely on some form of the unsatisfactory and always more or less insanitary privy for the disposal of excreta.

Typhoid control may be accomplished even in the absence of any sewers, but typhoid eradication can not. To control a system of privies necessitates constant watchfulness, frequent prosecutions, and a complete repetition of effort every few years. It is a most unsatisfactory procedure. If typhoid is to be eradicated, the surface privy and all individual methods of private sewage disposal must first be abandoned.

The measures referred to above comprise the fundamental groundwork of typhoid eradication in any municipality. By these measures the major portion of the work of reduction may be accomplished. Some years ago[1] the writer estimated that under average conditions at that time, water purification alone would, in a northern city, with sanitary conditions as usually found in such cities, and with a low percentage of negro population, result in a reduction of the typhoid death rate to a figure in the neighborhood of 20 per 100,000 population, per annum; while in a southern city, under the existing sanitary conditions, and with a high percentage of negro population, such a procedure would result in reducing the typhoid rate to approximately 50 per 100,000 per annum. Mr. George A. Johnson, the well known sanitary engineer and student of typhoid fever, has recently, in reviewing the subject, expressed the opinion that these figures were, in all probability, somewhat too high.[2] The table published with his paper, however, including 20 cities, of which only 4 are located in the south, would seem to prove that this estimate is perhaps not far from the truth. Exceptionally, as occurred in Cincinnati and Paterson, N. J., even more striking results may come from water purification alone.

The effect of the installation of a complete sewer system upon the typhoid prevalence, depends very largely upon the conditions existing prior to such installation. In general it may be said that in northern cities universal sewerage will, in the presence of a pure public water supply, reduce the typhoid death rate to approximately 10 per 100,000 per annum, and under the same conditions in the South, to an average death rate of approximately 20 per 100,000 per annum. These estimates, however, are subject to wide variations, since the instances of complete sewering of cities, north or south, are not sufficiently numerous to give reliable indications as to what may be expected from a more general application of the measure.

Assuming, therefore, that by the means previously mentioned, the typhoid death rate of any city may be reduced to a figure between 10 and 20 per 100,000 per annum, there remain for consideration the measures necessary for the reduction and final elimination of the residue. It must be recognized, of course, that as the typhoid rate diminishes its further reduction becomes increasingly difficult. The general causes, impure water and improper sewage disposal, which give rise to the larger part of the total rate, may be eliminated by general measures of an engineering nature, but with their elimination there remains for consideration a multitude of minor causes, each of which must be attacked separately if success is to be expected.

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[1] The Present Status of our Knowledge Regarding the Transmission of Typhoid Fever. Public Health Reports, Jan. 10, 1913.

[2] Johnson, Geo A., The Typhoid Toll, Journal American Water Works Association, Vol. III, No. 2, June, 1916.

The first of these minor causes of typhoid prevalence, and probably the most important from the quantitative standpoint, is infection of milk supplies. Upon the importance of this factor there has been considerable difference of opinion. Everyone recognizes the fact that milk-borne epidemics of typhoid not infrequently occur and that there is an additional possibility that a considerable number of cases are caused by milk infection in groups of persons not sufficiently large to be identified from the epidemiological evidence. Kelley, of Massachusetts, recently stated [1] that in only 5 per cent of the cases of typhoid in Massachusetts was milk infection definitely assigned as the cause and in only 6 per cent suspected to be the cause. These statistics are based on cases occurring in Massachusetts between 1909 and 1913. In defining a milk epidemic of typhoid fever, however, Kelley says: "In order definitely to declare any disease milk borne, however, it is necessary to carry out, by epidemiologic and laboratory means, a careful search for and detection of the disease, or a past history of the disease, in a person or the persons handling the milk at any point and a thoroughgoing exclusion of all other probable channels of infection." In view of the fact that every experienced investigator of typhoid has encountered epidemics undoubtedly due to milk-borne infection in which no direct connection, either epidemiological or laboratory, could be established with actual or previous cases of typhoid in persons handling the milk, and in consideration, further, of the fact that the epidemiological features of a milk-borne epidemic are very characteristic and constant, and in most cases practically unmistakable, Dr. Kelley's limitation of the definition seems unduly extreme.

Frost in a recent paper [2] reviews the subject fully, arriving at an estimate of the influence of epidemics of milk-borne infection in the causation of typhoid approximately the same as that stated by Kelley, but is inclined to think that the incidence of milk-borne infection, in groups too small to be identified as such is considerably higher than is assumed by Kelley.

We may safely assume, therefore, that in the eradication of typhoid fever from a city the prevention of milk-borne infection must have an important part.

The control of milk supplies has occupied an important place in public-health procedures in the past 10 years, and great improvements have already been made. It has become increasingly evident, however, that inspection alone, however efficiently performed, is not an adequate protection against milk-borne disease, and against typhoid fever in particular. The danger of infection of a large milk supply from a carrier or an abortive case of typhoid can not be avoided by inspection, or by the enforcement of any standard of cleanliness of equipment or methods. The danger of epidemics may be diminished by these means, but not entirely removed. It must be frankly recognized that the only really efficient protection against milk-borne typhoid is complete compulsory pasteurization, under public supervision, of the entire milk supply of a city. The percentage of the milk supply of any community which is effectively pasteurized is the measure of the protection of that community against milk-borne typhoid.

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[1] Kelley, E. R., J. A. M. A., LXVII, No. 27, p. 1997, Milk-Borne Infections.

[2] Frost, W. H., Relation of Milk Supplies to Typhoid Fever. Reprint No. 380, Public Health Reports, Dec. 1, 1916.

When the danger of infection from water, improper disposal of excreta, and milk has been removed, there remains a small residuum of typhoid infection, due to carriers, contact with known cases, and other minor factors. These can not be attacked and removed in mass, as can the major factors, but must be attacked individually. They demand for success a real interest and enthusiasm on the part of the health officer and a painstaking study of each case as it occurs and of the entire picture of the prevalence of the disease from month to month and from year to year. Among the measures which have been found of value in this battle of detail are the bacteriological examination of convalescents, the inspection and physical examination. including the Widal test, of food handlers, the registration and supervision of known carriers, and the prophylaxis of known cases, including hospitalization of cases and vaccination of exposed persons. The success of this work depends upon the personality and enthusiasm of the health officer and his assistants. It will be effective usually just in proportion as the health officer desires really to eradicate the disease from the community.

The example of the larger cities, New York, Boston, Newark, Providence, Cincinnati, Cambridge, Richmond and others in the reduction of typhoid practically to the vanishing point are examples of what may be accomplished by this work. So far no large city has been able to go through a year without a death from typhoid fever, but if the present rate of progress is continued, the time will not be long before this record will be made.

Present Conditions in Typhoid Prevention in Cities in the Ohio River Valley.

It has seemed to the writer that it might be of interest to compare the foregoing more or less idealistic statement of the relation of the municipality to the subject of typhoid prevention, with conditions as they actually exist in a group of cities located in the basin of the Ohio River. For this purpose a group of cities, twenty-four in number, having a population of 25,000 or over by the census of 1910, have been selected. This list includes all the cities over 25,000 in the Ohio Valley, except the three metropolitan cities of Pittsburgh, Cincinnati, and Louisville. These metropolitan cities have been omitted for the reason that they were not included in the survey from which the information regarding the smaller cities was obtained. Full information regarding them is not available. The information regarding the cities included in this study was collected in the course of a sanitary survey of the cities of the Ohio River Basin, conducted by the Public Health Service in connection with the study of the pollution of the Ohio River. Each of the cities was visited, and all the information was collected at first hand. The water supplies and sewer systems were inspected by a sanitary engineer of the service, and the information regarding the operations of the health departments of the cities was collected by a medical officer. It is believed that this information is as accurate as could be obtained, and fairly represents the conditions of the cities at the time the survey was made during the summers of 1914 and 1915. The surveys included the collection of information regarding the prevalence of typhoid during the five years prior to the time of the survey, and these years have been used in computing the average typhoid death rate of the cities.

In two cities, New Castle, Pa., and Evansville, Ind., important changes were made in the water supply during the period under consideration, and for that reason these two cities are considered only for the period since the change was made, the typhoid death rates being computed on these years instead of the full period of five years.

In view of the fact that figures for typhoid morbidity are incomplete or entirely lacking in certain of the cities, the studies of typhoid prevalence have been based entirely upon the deaths from typhoid fever, which are believed to be accurately registered in practically all the cities included in the study.

Table No. 1 gives the fundamental facts regarding the conditions affecting typhoid prevalence, as they were found to exist in the various cities at the time of the survey. The "rating" of the water supplies is a numerical expression of the sanitary quality of the water supply, based on 100 as the maximum, as assigned by the members of the survey party after a careful inspection of the source, safeguards, and methods of purification, and a study of all available records of laboratory examinations of the public water supply. It represents the opinion of the members of the survey party as to the sanitary quality of the water, after a careful examination of all available facts regarding it. These values were assigned without considering the actual prevalence of typhoid fever in the community.

The percentage of the population using the public water supply and the percentage connected with the sewers were determined as accurately as possible from the local records.

TABLE 1.—*Status of measures for the control of typhoid fever in 24 cities of 25,000 population and over in the Ohio Basin.*

[Includes all cities of 25,000 population in 1910 except Pittsburgh, Cincinnati, and Louisville.]

City.	Estimated population, 1915.	Water supply.			Sewers, per cent of population connected.	Milk.		Reporting typhoid.		Study of typhoid.		Is prophylaxis of cases under official control?	Deaths and average death rate per 100,000 from typhoid fever, 5 years, 1910-1914.	
		Source and treatment.	"Rating."	Per cent of population supplied.		Dairy inspection system?	Per cent of supply Pasteurized.	Per cent of known cases reported.	Per cent of known deaths reported.	Are all cases visited?	Are current cases studied?		Deaths.	Rate.
Canton, Ohio	59,139	Drilled wells	93	96	83	Yes	66	50	100	Yes	No		55	20.4
Dayton, Ohio	125,509	do	93	90	67	Yes	65	90	100	Yes	Yes	Yes	109	18.1
Hamilton, Ohio	39,655	do	95	80	33	No	85	95	100	Yes	No		30	16.1
Jamestown, N. Y.	35,729	do	98	97	95	Yes	15	90	100	Yes	No		32	19.2
Springfield, Ohio	50,804	Infiltration well, in old bed of creek.	85	95	38	Yes	85	90	100	Yes	Yes	Partial	51	21.0
Columbus, Ohio	209,722	Mechanical filtration, hypochlorite, Scioto River.	95	95	95	Yes	85	90	100	Yes	Yes	do	163	16.9
Lexington, Ky	39,703	Impounded creeks, mechanical filtration, hypochlorite.	90	80	33	Yes	25	50	100	Yes	Yes	do	58	31.3
Evansville, Ind	72,325	Ohio River, mechanical filtration, hypochlorite.	90	70	50	No	28	75	100	Yes	No		[1]38	[1]26.8
New Castle, Pa	40,351	Shenango River, mechanical filtration, hypochlorite.	87	70	80	Yes	20	90	100	Yes	No		[1]21	[1]26.8
Chattanooga, **Tenn.**	58,576	Tennessee River, mechanical filtration.	87	97	75	Yes	45	55	100	Yes	No		99	39.5
McKeesport, **Pa.**	46,743	Youghiogheny River, mechanical filtration.	86	93	55	Yes	40	90	100	Yes	No		77	34.7
Terre Haute, Ind.	64,806	Wabash River, mechanical filtration, hypochlorite.	85	52	40	Yes	40	50	100	No	No		90	29.6
Knoxville, Tenn.	38,300	Tennessee River, mechanical filtration.	83	95	90	Yes	36	55	100	No	No		74	39.8
Huntington, W. Va.	43,572	Ohio River, mechanical filtration.	80	90	70	Yes	5	10	75	No	No		60	41.7
Danville, Ill.	31,554	Vermilion River, mechanical filtration, hypochlorite.	75	75	47	Yes	10	90	100	Yes	Yes		52	35.3
Youngstown, Ohio	104,489	Mahoning River, mechanical filtration, copper sulphate.	[2]50	80	70	Yes	75	90	100	Yes	No		189	43.3

Indianapolis, Ind...	265, 578	Drilled wells and White River; latter mechanical filter, hypochlorite.	90	65	60	Yes.....	25	90	100	Yes.....	Yes.....	....	305	24.7
Johnstown, Pa......	66, 585	Impounding reservoirs on small streams; hypochlorite and chlorine.	65	94	50	Yes.....	49	90	100	Yes.....	Yes.....	....	89	29.5
Nashville, Tenn.....	115, 978	Cumberland River, coagulated and settled, hypochlorite.	80	68	60	Yes.....	18	75	100	Yes.....	Yes.....	Partial..	255	45.3
Covington, Ky......	56, 520	Ohio River, sedimentation and storage.	70	92	50	Yes.....	66	60	100	Yes.....	No......	....	37	13.6
Newport, Ky.......	31, 722	Ohio River, partial coagulation and hypochlorite, sedimentation and storage.	72	91	50	Yes.....	75	75	100	No......	No......	....	39	25.2
Newark, Ohio.......	28, 953	Infiltration system, and raw Licking River, untreated.	25	75	40	No......	33	50	100	Yes.....	No......	....	32	23.8
Zanesville, Ohio.....	30, 406	Muskingum River, hypochlorite.	15	90	40	No......	25	40	100	No......	No......	....	80	55.1
Wheeling, W. Va...	43, 097	Ohio River, untreated.....	0	50	65	No......	50	75	100	Yes.....	No......	....	120	56.8
Total population.	1, 699, 816	Weighted averages..	79.7	81	64	....	53	75	....	....	....	....	....	28.6

[1] Deaths and rates for 1913 and 1914 only.

[2] New plant since inspection.

NOTE.—All average death rates computed by dividing the total number of typhoid deaths by the sum of the populations for the years in which they occurred.

The percentage of the population using pasteurized milk was obtained by estimating the total amount of milk sold, as accurately as possible, and determining the amount pasteurized by a visit to all pasteurizing plants in the community.

The information regarding the collection and study of records of cases and deaths, and regarding case prophylaxis, was obtained from the health office by inquiry and inspection.

Water Supply.

Of the 24 cities included in this study, 5 use ground waters. Four of these supplies are taken from driven wells and the fifth from an infiltration well in an old creek bed. All were rated over 90 in quality except one. The rating for the supply from the infiltration well was 85. The weighted average rating of the group is 93.

Eleven cities used supplies from surface streams. These were filtered, after coagulation and sedimentation, and with two exceptions were afterwards treated with hypochlorite of lime. Three of these supplies were rated above 90, six between 80 and 90, one at 75, and one at 50. The last supply, however, that at Youngstown, Ohio, was under improvement at the time of inspection, and the new plant, rating 85, was put into operation early in 1915. The average weighted rating for the group of filtered supplies is 83.

Indianapolis is classified separately, as it possesses a mixed ground and filtered surface supply, rated at 90 on the scale used.

Johnstown, Pa., possesses a supply obtained from the impounding of small streams and used without any treatment other than storage. It was rated at 65.

Three cities use water from large rivers treated by settling. In one, Nashville, settling is aided by coagulation and sedimentation. The other two supplies have a period of storage of approximately 30 days. These supplies were rated 80, 72, and 70, respectively, the average weighted rating for the group being 75.

Three cities use untreated surface waters, from polluted streams. One is taken from the headwaters of the Muskingum River, one from Licking River, and one from the Ohio River 68 miles below Pittsburgh. The rating of these supplies is respectively 25, 15, and 0. The Ohio River 68 miles below Pittsburgh is believed to be totally unfit for consumption without treatment.

Of the 24 cities, therefore, 8 have supplies which rate as 90 or over, and may be considered as excellent. Eight have supplies rating between 80 and 90, which may be considered as good, while eight have supplies rating below 80, three of the eight being in the positively dangerous class.

The average rating of the water supplies, for the entire group weighted according to population, is 79.

The percentage of use of these water supplies by the various cities shows wide variations. In 13 cities the public water supply is in use by 90 per cent or more of the population. In 3 cities between 80 and 90 per cent use the public water. In 4 between 70 and 80 per cent, in 2 between 60 and 70 per cent, and in 2 between 50 and 60 per cent use the public supply. The lowest percentage of use, 50 per cent, is in Wheeling, W. Va., which has also the doubtful distinction of possessing the water supply of lowest rating.

Taking the group as a whole, 81 per cent of the population use the public water supply.

Sewage Disposal.

The status of the sewage disposal conditions in the various cities is expressed by the percentage of the population connected with sewers. No account is taken of sewage purification systems, since these are chiefly for the benefit of those living further downstream. The result sought is the promptness and efficiency of the removal of human excreta from the community and is best expressed by the percentage connected with the sewers. As will be seen from the table, this varies widely. The highest percentage is 95, for Columbus, Ohio, while only three cities altogether have over 90 per cent connected. Two have between 80 and 90 per cent connected, three between 70 and 80, four between 60 and 70, five between 50 and 60, four between 40 and 50 and three between 30 and 40 per cent.

Taking the group as a whole, therefore, only 64 per cent of the total population is connected with the sewers, the remaining 36 per cent still depending upon one form or another of the insanitary and archaic privy.

Milk.

All but five of the twenty-four cities have some form of dairy inspection, and all have partial pasteurization. None, however, has complete pasteurization, the nearest approach being made at Columbus, Springfield, and Hamilton, Ohio, which have pasteurization of 85 per cent of the total milk supply. The average percentage of the milk supply which is pasteurized, weighted according to population, is 53 per cent.

Reporting, Study, and Prophylaxis of Cases.

The reporting of cases of typhoid in the various cities varies from 10 to 90 per cent in completeness, the weighted average for the group being 75 per cent.

Reporting of deaths is approximately complete for all cities of the group except for Huntington, W. Va., where it is estimated to be 75 per cent complete.

In all but five of the cities a visit is made to the home of reported cases of typhoid fever by some representative of the health department, usually by a sanitary policeman or some other untrained person.

In only seven of the cities is any systematic study made of reported cases of typhoid. In most of the cities the reports are filed and no further attention is paid to them. In seven of the cities, however, current chronological charts and spot maps of the cases are made in such a manner as to make it probable that even a small outbreak of typhoid would receive immediate attention.

The prophylaxis of cases is left almost entirely to the efforts of the private physician, only five cities making any effort to supervise prophylaxis other than leaving a printed circular at the home of the patient.

Summarizing the progress of these cities toward the ideal of typhoid eradication, therefore, we find that in the furnishing of good water to every citizen the work is approximately two-thirds complete, in that water of 80 per cent quality is furnished to 80 per cent of the population. In sewerage the work is approximately two-thirds done; in pasteurization of milk, one-half done; and in real typhoid study and prophylaxis not more than one-third done.

Typhoid Prevalence.

The typhoid prevalence of the group of cities gives an average death rate per 100,000 for the five years of 28.6, as against 18.7 for the registration area as a whole and as against an average rate of 16 per 100,000 per annum for the same period as exhibited by the three metropolitan cities of the watershed—Pittsburgh, Cincinnati, and Louisville

This rate reflects with considerable accuracy the condition of the group of cities as regards water supply, sewage disposal, milk control, and general typhoid control. The rates vary widely, the lowest rate being that for Covington, Ky., which is located in the Cincinnati metropolitan district. The highest rates are those for Wheeling and Zanesville. These are readily accounted for by the condition of the public water supply of these cities.

The influence of water supply in causing this undue prevalence of typhoid is demonstrated quite strikingly by grouping the cities in classes according to their water-supply rating and computing the typhoid death rate for each group. The following table shows the results of this grouping. It will be seen that the group of cities having the highest water-supply rating (92.8) shows the lowest death rate from typhoid (21.1), while the group with the lowest water-supply rating (11.3) shows the highest typhoid death rate (47.3). In general the typhoid death rates vary quite regularly in inverse proportion to the water-supply rating, with the exception of the group with ratings between 60 and 70. This group contains only three cities, one of which, Danville, Ill., has a rather high rate, but the other two have rates quite low, one, Covington, Ky., having the lowest rate of any city in the group, notwithstanding the fact that its rating for water supply is only 70, and only 50 per cent of the population is connected with the sewers.

Table 2.—*Summary of water-supply ratings, etc., by groups, with weighted averages and typhoid deaths and death rates.*

Group with ratings.	Number of cities.	Total population of cities of group, 1915.	Weighted average water supply rating of group.	Per cent of population using public supply.	Per cent connected with sewer system.	Total typhoid deaths, 1910 to 1914.	Average death rate for group, 1910 to 1914.
90 to 100	8	847,360	92.8	81.4	69.3	[1] 790	21.1
80 to 90	8	459,130	84.5	79.5	61.3	[2] 727	36.5
70 to 80	3	119,796	71.7	87.5	49.3	128	22.3
50 to 70	2	171,074	56.1	85.4	62.2	278	37.7
0 to 50	3	102,456	11.3	68.9	50.5	232	47.3
Total	24	1,699,816	79.7	81.0	64.0	2,155	28.6

[1] Includes Evansville, Ind., for years 1913–14 only

[2] Includes Newcastle, Pa., for years 1913–14 only.

The low typhoid death rates of Covington and Newport have been of great interest in the whole course of the study. The two cities are located just across the river from Cincinnati, and are not remarkable for their sanitary development or administration. The water supply of the two is taken from the Ohio River just above Cincinnati, and is treated by simple settling and storage for a period of 30 days. Newport adds a small quantity of coagulant and a very small amount of hypochlorite of lime. From the standpoint of the raw water, the methods of treatment and the bacteriological quality of the water supplied, which have been carefully examined, the water can not be considered of the highest quality. In spite of these facts, the towns have been remarkably free from typhoid fever for a number of years. It would seem probable that the effect of settling and storage on the typhoid organisms which are most probably frequently present in the raw water is somewhat selective, and that the actual purification of the water as regards destruction of typhoid bacilli is considerably more efficient than is indicated by the results of the ordinary bacteriological and chemical tests.

The differences in the typhoid prevalence of the different groups of cities arranged according to their rating for water supply are shown also, quite strikingly, by differences in the seasonal prevalence of the disease in the different groups. This is shown by the following table which gives the whole number of typhoid deaths each month for each group, and also the average equivalent annual death rates per 100,000 by months.

TABLE 3.—*Seasonal distribution of typhoid fever in 24 cities of 25,000 and over in Ohio River basin.*

[Arranged in groups according to water supply rating, showing total deaths in each month and equivalent average annual death rates by months.]

Water supply rating.	Months.												Total for year.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Group 90-100:													
Deaths	40	37	40	39	33	39	62	124	133	98	79	57	[1] 781
Equivalent annual rate	13.1	12.1	13.1	12.7	10.8	12.7	20.3	40.4	43.4	32.0	25.8	18.6	21.2
Group 80-90:													
Deaths	42	28	26	30	35	47	97	102	113	100	60	47	727
Equivalent annual rate	25.3	16.9	15.7	18.1	21.1	28.3	58.4	61.4	58.1	60.2	36.1	28.3	36.5
Group 70-80:													
Deaths	5	11	4	12	6	9	10	19	20	18	4	10	128
Equivalent annual rate	10.2	22.9	8.4	26.1	12.5	18.8	20.9	39.7	41.7	37.6	8.4	20.9	22.3
Group 50-70:													
Deaths	11	31	32	19	22	9	14	26	32	34	25	23	278
Equivalent annual rate	17.9	50.4	52.0	30.9	35.8	14.6	22.8	42.3	52.0	55.3	40.6	37.4	37.7
Group 0-50:													
Deaths	17	13	16	17	14	10	7	12	18	11	10	20	[2] 165
Equivalent annual rate	56.1	42.8	52.7	56.1	46.1	33.0	23.0	39.5	59.3	36.2	33.0	65.8	45.3
All cities:													
Deaths	115	120	118	117	110	114	190	283	316	261	178	157	2,079
Equivalent annual rate	18.8	19.6	19.3	19.1	18.0	18.6	31.1	46.2	51.6	42.6	29.0	25.7	28.3

[1] Includes deaths for Evansville, Ind., for 1913 only; 9 deaths occurring in 1914 omitted; monthly distribution unknown.

[2] Includes deaths for Wheeling, W. Va., for 1912 and 1913 only; 67 deaths in 1910, 1911, and 1914 omitted; monthly distribution unknown.

It will be seen from the accompanying chart that the group of waters rating between 90 and 100 shows a curve quite characteristic of a pure water supply, running almost level during the winter months with a characteristic rise during the summer months.

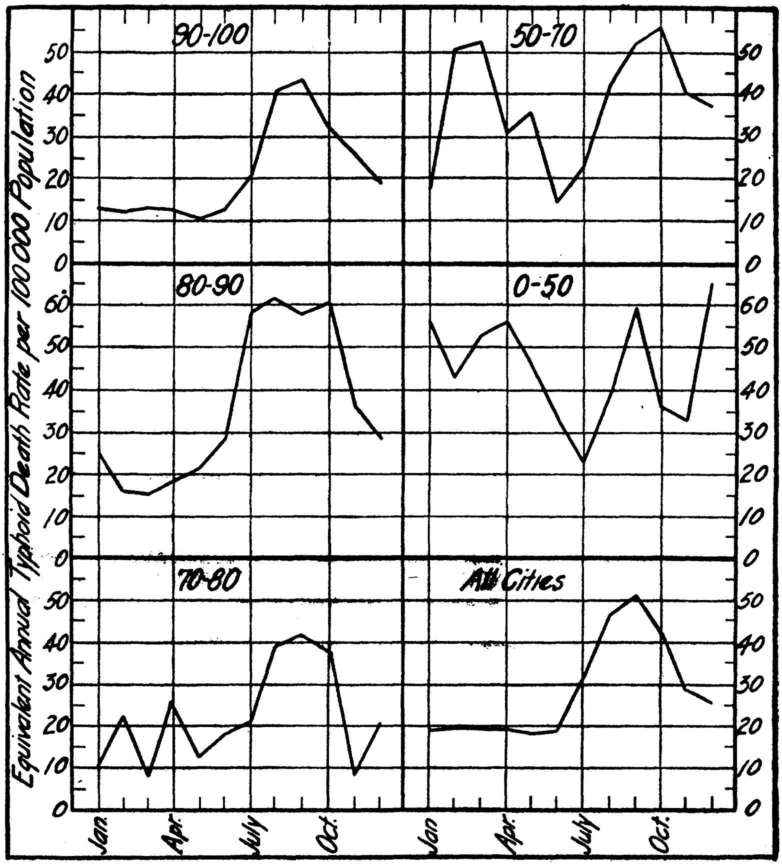
The next group of supplies, rating from 80 to 90, shows the same general shape of curve, higher in its whole course, and with a somewhat prolonged peak. The shape of this curve is no doubt modified by the fact that it contains a considerable number of the larger southern cities whose typhoid under similar conditions of water supply will consistently show a higher rate than the northern cities and the crest of whose prevalence comes somewhat earlier than in the northern cities. For these reasons this rate is probably higher and the curve broader than would have been the case had the group, like the first group, contained only northern cities.

The next group, containing Covington and Newport, has been previously discussed. While the total rate, as compared with the rates of the first group, does not evidence water infection, the general shape of the curve is somewhat irregular and shows several winter crests which are usually taken to indicate the possibility of water-borne infection.

The group containing the cities with water-supply ratings between 50 and 60 shows, likewise, a winter peak and an abnormally high prevalence. The last group, rating below 50, shows the characteristically irregular curve commonly found in cities using grossly polluted water.

Conclusions.

The prevalence of typhoid fever in the group of cities included in this study bears out strikingly the conclusions drawn from a study of the means of typhoid prevention employed. The major factors in typhoid causation, polluted water and improper disposal of human excreta, are still largely operative. The minor factors, with the exception of the pasteurization of milk, are largely ignored. This group of cities, fairly representative of a very large class of American municipalities, still suffers from an excessive prevalence of typhoid fever, due to well understood and easily preventable causes.



Seasonal prevalence of typhoid fever in 24 cities in the Ohio River basin, arranged in groups according to quality of water supply as expressed by "water-supply rating."